

Using a Triple Helix approach to examine interactions and dynamics of innovation in less-favoured regions: The case of the Portuguese Polytechnic of Guarda

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Abstract

Using the Triple Helix model, this article examines the contribution of a higher education institution, the Polytechnic of Guarda (PG), located in an inland, a less-favoured region of Portugal, to territorial innovation dynamics. The main goal is to explore how the interaction and cooperation between the three helices of the Guarda region (PG, companies and local governance institutions) fosters innovation and development in a less-favoured region in a sustainable way, generating new patterns of collaboration among the helices. The study investigates the behaviour of the three helices through an online survey. The results suggest that PG has a key role in building a knowledge-based society, in advancing innovation and the development of the region. Its role in business dynamics and community development through knowledge transfer and entrepreneurship training is reflected mainly in the high proportion of businesses and institutions of the local governance system that have workers trained in this institution, and in the satisfaction (medium and high) with the work performed by professionals trained at PG. Although the other helices (companies and local governance institutions) are also involved in innovation to different degrees, the innovation performance of the region remains low because of weak interactions between companies and PG, and between companies and local governance institutions. However, a closer relationship is identified between local governance institutions and PG.

Keywords

Innovation systems, regional development, regional innovation dynamics, territorial innovative capacity, Triple Helix

Interactions between Triple Helix actors, such as higher education institutions (HEIs), companies and government agencies, lie at the heart of innovation and constitute a basic premise of economic development (Dzisah and Etzkowitz, 2009; Pugh, 2014). In knowledge-based societies, these interactions improve the conditions for innovation and also become a source of innovation when they lead to the conversion of science and technology into economic advances (Etzkowitz, 2002). Recent regional innovation studies based on the Triple Helix approach have identified different patterns of innovation and development, subject to the relative power of the three helices. Other studies have investigated the relationship between HEIs and the economic resources of a region, with strong implications for regional innovation (Augustinaitis and Reimeris, 2012; Comunian et al., 2014; Suciu et al., 2013).

This study analyses the contribution of one HEI, the Portuguese Polytechnic of Guarda (PG), to the territorial

dynamics of innovation in the Triple Helix model. To investigate how PG fulfils its role in the Triple Helix and fosters the territorial dynamics of innovation, the study analyses the behaviour of PG in conjunction with two other helices that are present in the area: local companies and the governance system of the Guarda region. The goal here is to explore how relationships of interaction and cooperation between the helices foster innovation and development in this less-favoured region in a sustainable way, generating new patterns of collaboration among the helices.

The article is organized as follows: the next section provides a literature review; the subsequent two sections,

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respectively, describe the methodology used and set out the primary findings, discussing the results derived their implications; and the final section presents the conclusions.

Literature review

In the last two decades, several innovation studies based on the Triple Helix have highlighted the key roles played by the three helices (university, government and industry) at regional and national level. For example, Casas et al. (2000) studied the emergence of regional knowledge spaces in Mexico, supported by institutional interactions between public research centres and firms, and stimulated by government intervention. Rolfo and Calabrese (2006) and Defazio and Garcia-Quevedo (2006) highlight the role of regional government in shaping local science and technology/research and development systems in Italy and Spain, respectively. Castro et al. (2000) and Natário et al. (2012) discuss a Triple Helix-based model of organizing institutional networks in national and regional systems in economies based on traditional and mature sectors and in less-favoured regions. Various patterns of Triple Helix cooperation among innovation actors have also been identified in Sweden (e.g. Coenen, 2007; Coenen and Moodysson, 2009; Danell and Persson, 2003), Finland (e.g. Jauhiainen and Suorsa, 2008), United Kingdom (Smith and Bagchi-Sen, 2010) and Central European countries (Huggins, 2008). A recent study by Yegorov and Ranga (2014) analyses the emergence of a Triple Helix system in a non-EU country – Ukraine – and the ways in which the country's cooperation with the European Union has influenced the development of such a system.

Another stream of Triple Helix studies looks into patterns of institutional cooperation among the helices. For example, Ranga et al. (2016) examine the technology transfer capacity of Turkish universities and identify characteristics typical of an incipient stage of technology transfer development, with relatively low levels of cooperation among Triple Helix partners (Ranga et al., 2016: 99). Gordon (2016) analyses a university knowledge exchange programme for owners and managers of small and medium-sized enterprises, and Alves et al. (2015) study the impact of Portuguese polytechnic institutes on the local economy, concluding that 'the impact of polytechnic institutes goes far beyond the economic dimension, namely in aspects not easily quantifiable, such as sociocultural benefits and equality of access to higher education for these regions' (Alves et al., 2015: 15).

The trilateral collaboration between the helices stimulates innovation by providing a balance in knowledge, social benefits, profits and motivations. Moreover, it strengthens local and national partnerships through joint research programmes and influences human and material resources to generate solutions and new knowledge (Etzkowitz and Zhou, 2007). Thus, the articulation of

relationships among the three helices in different contexts will facilitate the design of research, development and innovation policies (Villarreal and Calvo, 2015) and help the development of innovation. Critically important in this process is the governance of Triple Helix interactions, through what Ranga and Garzik (2015) call 'the consensus space', which may further lead to new developments in the 'knowledge space' and the 'innovation space'.

HEIs play a central role in innovation dynamics and regional development: Beyond the traditional role of teaching and research activities, they also perform knowledge transfer, business training and community development. Taking on an entrepreneurial role, they can accelerate economic and social dynamics, by aligning their teaching and research functions with the role of incubator (Vang-Lauridsen et al., 2007). HEIs' entrepreneurial activities can not only drive regional and national economic development and competitiveness but can also generate financial benefits for researchers (Farinha and Ferreira, 2013; Leydesdorff and Etzkowitz, 1996). The interaction between the helices generates benefits for HEIs and for companies (Almeida, 2010; Natário et al., 2011; Segatto and Mendes, 2001) and can stimulate the innovation process and regional development. This approach requires HEIs to have more flexible organizational patterns and human and structural resources that are able to perform various roles in the innovation process beyond the traditional ones:

Higher education performs an important role in revitalising regional economies especially when taking into account all the related expenditure on and off academic campuses, whether on personnel, investment in research and new projects, medical installations, arts and cultural events, hosting conferences and congresses, equipment and other infrastructures as well as food and beverage outlets. (Farinha and Ferreira, 2013: 15)

Methodology

Research aim

The aim of this study is to investigate how PG fulfils its role in the Triple Helix model (Dzisah and Etzkowitz, 2009) and helps to promote the territorial dynamics of innovation in the less-favoured Portuguese region of Guarda. To this end, it is important to ascertain whether there is dynamic innovation and cooperation among companies, HEIs and the government, and to identify the main types of cooperation between them and the main drivers of that dynamic.

Research scope

The research encompassed various institutions representing the three helices in the Guarda region, as follows:

- *The HEI sector*, represented by PG, with its four schools.
- *The industry sector*, represented by a set of local companies selected from the database of the National Institute of Statistics of Portugal for 2009. From this database, only companies with an email address were selected, in order to avoid the financial and environmental costs associated with paper surveys. Based on this selection criterion, of 3740 companies included in the database 155 were selected, but only 30 companies completed the survey.
- *The government sector*, represented by a number of affiliated institutions such as local government agencies; local/regional public institutions of health, employment, protection and social security; regional/local business associations and private institutions of social solidarity, totalling 52 institutions, of which 26 completed the survey.

Other actors usually included in the so-called fourth helix (non-governmental organizations, international organizations, civil society, individual citizens) were also considered through an inquiry made to the President of PG and its four schools, in order to collect the necessary information and to understand their interaction with the environment.

Main research tool

The main tool for collecting the required information was an online survey conducted through *docs.google.com*. The survey consisted of a set of questions reflecting the research variables considered relevant to the study, based on the literature review performed.

The survey was divided into three parts. The first part solicited information to identify the respondent. The second part included questions exploring the innovative behaviour of companies and other institutions. More specifically, it asked whether these institutions had introduced innovation in the last 3 years and, if so, what types of innovation had been introduced (product, process, organizational, marketing, or ecological innovation, or innovation to reduce materials and energy and to improve health and safety). The third part of the survey was concerned with the collaboration and interaction among the three helices that nourish the 'circulatory system' of the region and promote the dynamics of innovation. The questions referred to different types of cooperation between firms, governance institutions and PG – for example, the use of services, research studies, employee training, the use of equipment, trainee recruitment, registration of patents and other intellectual property rights protection, promotion, dissemination and public relations, promoting partnerships and networking opportunities, consulting support, negotiations support, defining strategies for technology transfer, participation in business incubation and technology parks, and

sponsorship and restructuring teaching content. These questions explored different types of cooperation (e.g. cooperation agreements, formal and informal, relating to access to information and resources, provision of services, developing regional events, training, etc.) and the most important actors involved in the cooperation process over the past 5 years: for example, universities/polytechnics, PG, business associations, consultants, customers and suppliers, research centres, other firms and local governance institutions.

The questionnaire also included questions about the benefits that HEIs, companies and the local governance system derive from their mutual interaction and cooperation. Thus, the questions, on a Likert scale of 1 to 5 (1 = very weak, 5 = very good), evaluated the following benefits: fulfilment of the social function of PG, obtaining practical knowledge about existing problems, incorporation of new knowledge into teaching and research practices, securing additional financial resources, acquisition of extra material resources, prestige for the researcher, enhancement of PG's image, introduction of new products, improvement of production processes and innovation, access to highly qualified people from the universities, solution of technical problems that require research, reduction of costs and risks involving R&D projects, access to knowledge obtained in the educational field, identification of students for future hire and access to specialized market studies. The aim was to identify the main services appreciated and used by each helix and to stimulate the dynamics of interaction.

The survey for the HEI sector was conducted at PG and its four schools and at the other institutions mentioned above (government helix) from February to May 2012. PG and its schools answered the survey. As noted before, of 52 institutions in the government helix, only 50% completed the survey. This helix included public and private institutions with decision-making power, of which 31% were local governance institutions, 23% were from the corporate sector and 27% were from the health sector. The remaining institutions had employment (4%), social security (4%) and protection (4%) as their main activity. Overall, this set of institutions associated with the government helix reflects the structure of the local governance system, rather than just local government. Most of the institutions surveyed had between 11 and 49 workers, and only a few counted between 100 and 250 workers.

The survey for companies was conducted between November 2011 and February 2012 by email. As noted above, of 155 selected companies, only 30 answered to the survey. Among them, 40% belonged to the services sector, 33% to industry, 13% to commerce, 7% to agriculture and 7% to construction. A large percentage (about 85%) of the companies surveyed were small or very small with fewer than 50 employees. Ninety percent of companies surveyed had been operating for more than 5 years.

Table 1. Types of innovation in the three helices.

	Firms		Governance institutions		PG	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Introduced innovation in last three years	0.87	0.346	0.84	0.374	1	0.00
Innovation_improvement_products	0.70	0.466	0.76	0.436	1	0.00
Innovation_improvement_process	0.70	0.466	0.72	0.458	1	0.00
Innovation_reorganization	0.57	0.504	0.64	0.490	0.8	0.45
Innovation_marketing	0.27	0.450	0.44	0.507	0.4	0.55
Innovation_ecology	0.27	0.450	0.32	0.476	0	0.00
Reducing labour costs	0.70	0.466	0.44	0.507	0.6	0.55
Reducing the use of materials and energy	0.70	0.466	0.60	0.500	1	0.00
Health and safety	0.73	0.450	0.64	0.490	0.6	0.55

PG: Polytechnic of Guarda.

Source: Survey of firms, institutions and PG.

Due to the relatively low response rates to the questionnaire overall, the sample is not representative of the population of enterprises in the Guarda region, leading us, statistically, to a case study.

Results

In this section, we divide the discussion into two parts. First, we discuss the results related to innovation performance and then we consider the dynamics of interaction and cooperation between the helices.

Innovation performance

Analysing the innovative behaviour of firms, the governance system and PG, positive behaviour was observed. Most companies had introduced innovations, mainly in health and safety, in new or improved products or in processes for cost reduction. The governance institutions also demonstrated positive innovative behaviour, expressed mainly by new or improved products or processes and organizational innovations in health and safety.

The results presented in Table 1 suggest that PG accomplishes its role in the Triple Helix model through a broad range of innovation processes, from products and processes to organizational innovations and reductions in materials and energy. Similar positive behaviour was also identified for the other helices.

Thus, the results show innovative behaviour on the part of all three helices, which are characterized by a strong commitment to generate innovation.

Dynamics of interaction and cooperation between the helices

Here, we analyse whether each helix acts from a dynamic perspective, from which it interacts both vertically and horizontally with the others, or whether it is individually engaged in innovation from a static perspective (Etzkowitz

Table 2. Cooperation in the Helix: firms and governance institutions (%).

	PG (%)	Firms (%)	Governance institutions (%)
Introduced innovations in collaboration with other helix/HEI	80	7	20
PG/firms/institutions have established a cooperation agreement	100	24	84
Cooperation with universities/polytechnics	100	17	67
Cooperation with PG	–	7	30
Cooperation with business associations	100	33	29
Cooperation with consultants	0	23	50
Cooperation with customers/suppliers	100	50	13
Cooperation with research centres	100	7	13
Cooperation with other firms/institutions	100	27	17
Cooperation with local government	100	10	33
Not applicable	–	17	4

PG: Polytechnic of Guarda; HEI: higher education institution.

Source: Survey of firms, institutions and PG.

and Zhou, 2007). The interaction among HEI (PG), companies and the governance system is seen as a key factor for improving innovation conditions in the region (e.g. Alves et al., 2015; Etzkowitz, 2002; Farinha and Ferreira, 2013; Gordon, 2016; Ranga et al., 2016), as discussed in our literature review above.

Table 2 shows a collaborative process evolving at different intensities. For example, the companies generally had introduced innovations during the past 3 years, but most had done so through individual efforts and only 7% had cooperated with other helices for that purpose, in spite of the fact that a relatively high proportion of the companies (24%) had concluded cooperation agreements (formal/informal) with other firms/institutions to access

information and resources. Similarly, the governance institutions indicated that only 20% of their innovations had been introduced in collaboration with other helices, although 84% had concluded cooperation agreements. This raises interesting questions about the objectives of cooperation agreements and their effectiveness – in other words, how much of the cooperation carried out within the framework of those agreements leads to innovative changes in the collaborating institutions. However, this aspect was not examined in depth in the study.

We can also see from Table 2 that about 17% of the firms had cooperated with HEIs for innovation and 7% with PG. These results agree with those obtained for Portugal by the Community Innovation Survey (DGEEC, 2016) – around 9% of companies with innovation products and innovation processes cooperate with HEIs. The preference is for collaboration with customers and suppliers (50%), followed by business associations (33%). The institutions of the local governance system, in general, had introduced innovations in the past 3 years, but not only individually. About 84% said they had established cooperative agreements (formal and informal) with companies or other institutions (for access to information and resources). About 67% of them had cooperated with HEIs and 30% with PG. The preference of governance actors is for collaboration with HEIs (67%), followed by consultants (50%) and local public administration (33%).

PG and its schools had developed cooperative relationships with companies and other local institutions. All schools said they had established cooperation agreements (formal and informal) with companies and other institutions to access information and resources. Innovation was not carried out in isolation, but in partnership with the other helices (80%).

Analysing these results, one can see a weak interaction between companies of the Guarda region and PG (7%), and between business and local government (10%). However, between the governance system and HEIs/PG, there is a greater interaction (67% with HEIs and 30% with PG). From PG's point of view (the HEI helix), there is high openness to cooperation and interaction with other helices and an overall stimulation of the circulatory system (Table 2).

The results given in Table 3 show that the main forms of collaboration for the companies were the provision of services and the use of equipment. For the governance actors, the main forms were the provision of services, recruitment of trainees and research studies. Finally, for PG, the main types of cooperation were employee training, the use of equipment and sponsorship and restructuring of courses.

It must be emphasized that about 45% of institutions in the region and 45% of companies still do not have information about the training offered by PG (see Table 4). However, in the last 2 years, PG has launched a nationwide

Table 3. Types of cooperation between firms/governance institutions and PG.

Type of cooperation	Firms (%)	Governance institutions (%)	PG (%)
Services	17	43	60
Research studies	7	39	60
Employee training	7	17	80
Use of equipment	13	9	80
Trainee recruitment	7	39	60
Registration of patents and other intellectual property rights protection	0	4	20
Promotion, dissemination and public relations	0	13	40
Promoting partnerships and networking opportunities	7	22	40
Consulting support	7	13	0
Negotiations support	0	0	0
Defining strategies for technology transfer	7	9	20
Participation in business incubation and technology parks	0	4	40
Sponsorship and restructuring of courses	0	4	80

PG: Polytechnic of Guarda.

Source: Survey of firms and institutions.

Table 4. Knowledge of PG training offer.

	None	Low	Medium	High	Very high
Knowledge of PG training offer by firms					
N	7	6	7	6	3
%	24	21	24	21	10
Knowledge of PG training offer by institutions					
N	2	8	6	0	6
%	9	36	27	0	27

PG: Polytechnic of Guarda.

Source: Survey of firms and institutions.

intensive publicity and marketing campaign to address this lack of information. Increasing government–industry–HEI cooperation has also been among the policies of the present presidency of PG.

It can be seen from Table 5 that PG and its schools do not appear to have a real knowledge of the demands and needs of enterprises and local institutions, and this lack is an obstacle to the achievement of the third mission: economic and social dynamics.

As noted by, for example, Etzkowitz and Zhou (2007), Villarreal and Calvo (2015) and Ranga and Garzik (2015), the interaction between the helices is important to stimulate regional innovation dynamics and can generate benefits for HEIs and also for companies and governance

Table 5. PG's knowledge of regional requirements (%).

	None	Low	Medium	High	Very high
Enterprises' needs		40	20	40	
Local institutions' needs		20	40	40	

PG: Polytechnic of Guarda.

Source: Survey of firms and institutions.

Table 6. Benefits to PG from cooperation with other helices.

	Viewpoint of PG	Viewpoint of firms	Viewpoint of governance institutions
	Mean	Mean	Mean
Fulfilment of PG's social function	3.8	3.63	3.82
Obtaining practical knowledge about existing problems	3.6	4.15	4.00
Incorporation of new knowledge into teaching and research practices	3.8	3.95	3.76
Securing additional financial resources	2.75	3.47	3.05
Acquisition of extra material resources	2.5	3.37	3.00
Prestige for the researcher	3	3.89	3.95
Enhancement of PG's image	4.25	3.94	4.14

PG: Polytechnic of Guarda.

Note: Likert scale 1–5; over 3 suggests high benefits of cooperation perceived.

Source: Survey of firms, institutions and PG.

systems. From the firms' perspective, the interaction and cooperation between the helices leads to benefits for PG, mainly in terms of obtaining practical knowledge of current problems, incorporation of new information into the processes of teaching and research and dissemination of PG image. Note that the possibility of obtaining resources (financial and material) in this way was not fully accepted (see Table 6).

From the point of view of local institutions (the governance system), the interaction and cooperation between the helices leads to benefits for PG, mainly with regard to promoting its image, obtaining practical knowledge about current problems, prestige for the researcher and for the institution, and the incorporation of new information into the processes of teaching and research. From PG's point of view, the interaction and cooperation between the helices leads to benefits, mainly with regard to image promotion, fulfilling its social function and incorporating new information into the teaching and research processes to increase knowledge about the needs of business. Cooperation as a means of obtaining financial and material resources is low for this helix (Table 6).

Table 7. Benefits to business and governance institutions from interaction and cooperation with HEIs.

	Viewpoint of firms	Viewpoint of governance institutions	Viewpoint of PG
	Mean	Mean	Mean
Introduction of new products	3.29	3.50	3.4
Improvement of production processes and innovation	3.52	3.74	3.8
Access to highly qualified people from universities	3.90	3.89	4
Solution of technical problems that require research	3.50	3.28	3
Reduction of costs and risks of R&D projects	3.15	3.35	2.6
Access to knowledge obtained in the educational field	3.90	3.86	3.8
Identification of students for future hire	3.60	3.70	3.8
Access to specialized market studies	3.22	3.40	2.2

PG: Polytechnic of Guarda; HEIs: higher education institutions.

Source: Survey of firms, institutions and PG.

For companies, the most important benefits of cooperation with HEIs are access to highly skilled resources and new knowledge developed in an academic environment. For institutions of the governance system, the most important benefits are access to the highly skilled resources of HEIs, access to new knowledge developed in an academic environment, improvement of production processes/innovation and identification of students for future recruitment (Table 7).

From the point of view of PG and its schools, for companies and institutions of the governance system, the most important benefits are access to the highly skilled resources of HEIs, access to new knowledge developed by academics, improvement of production processes/innovation and identification of students for future recruitment. PG does not consider access to specialized market studies as one of the most important benefits for companies and local institutions. The distance between the productive sector and knowledge institutions is, then, discernible in the low values attributed by PG to access to specialized market studies and the sharing of the costs and risks involved in research and development projects.

Note that the main reason companies give for *not* hiring the services of HEIs relates to the lack of need and/or applicability, but there is also the factor of unfamiliarity with the services available. For the governance helix, the main reason for not hiring the services of HEIs is, again, the lack of need and/or applicability (Table 8).

Table 8. Reasons for not hiring services of HEI.

	Firms		Governance institutions	
	Frequency	%	Frequency	%
Unfamiliarity	10	40.0	2	11.8
No need/not applicable	11	44.0	13	76.6
Not adapted	2	8.0	2	11.8
Complexity of process	2	8.0	—	—
Total	25	100.0	17	100

HEI: higher education institution.

Source: Survey applied to firms and institutions.

Discussion

Given the above results, one can conclude that the interaction between HEIs, companies and governance institutions leads to the conversion of scientific and technological progress into economic activity, as Etzkowitz and Zhou (2007) proposed. In our survey, such collaboration emerged in diverse types of innovation in firms and governance institutions over the past 3 years (more than 80%) (Table 1) and, of these, 7% of firms and 20% of governance institutions had introduced innovations in collaboration with HEIs (Table 2). Thus, PG is playing a crucial and innovative role in society because it is fulfilling its traditional role of teaching while at the same time developing research activities, knowledge transfer, business training and community development (Etzkowitz, 2002). However, within the framework of the Guarda Triple Helix model, the helices do not intertwine in the development of innovation as advocated by Leydesdorff and Etzkowitz (2000) and Dzisah and Etzkowitz (2009); rather, they exhibit low levels of collaboration (Table 2). For this reason, the circulatory system of the Triple Helix and the sustainable development of the region are weak.

Additionally, as described by Vang-Lauridsen et al. (2007) regarding the role of HEIs, PG also recognizes a third mission with explicit economic and social objectives, showing the economic and social dynamics of an entrepreneurial institution and assuming the role of incubator. As an incubator, PG has the 'Policasulos Project', a business incubation space located in certain classrooms with specific equipment, in which entrepreneurial teams of teachers and students can work together and start a business. These 'pods' are small research and development centres of ideas and innovative projects that will lead to new businesses in the region. The incubator also develops other entrepreneurship-related activities, such as the 'Poliemprende' contest, seminars on entrepreneurship, entrepreneurship curricular units in some courses, and a master's degree in innovation and entrepreneurship.

The robustness and sustainability of territorial development processes is based on the collective capacity for the mobilization, organization and recovery of resources by

Table 9. Benefits for PG, companies and governance institutions of interaction and cooperation.

Benefits for PG	Benefits for companies/governance institutions
<ul style="list-style-type: none"> • Realization of social function of the university • Acquisition of practical knowledge about existing problems • Incorporation of new information into processes of teaching and research • Securing additional financial resources • Obtaining additional material resources • Prestige for researcher • Enhancement of university's image 	<ul style="list-style-type: none"> • Introduction of new products • Improvement of production processes and innovation • Access to highly qualified people in universities • Solutions for the problems that led to the need for research • Reduced costs and risks in R&D projects • Access to new knowledge developed by academics • Identification of students for future recruitment • Access to specialized market

PG: Polytechnic of Guarda.

Source: Adapted from Segatto and Mendes (2001); Almeida (2010) and Natário et al. (2011).

local actors (Fermission, 2005) and are conditioned by the institutional and relational density of the territory (Natário, 2014). In the Guarda region, the feeble relational density with companies affects innovation and competitiveness levels. Thus, a governance model for the region is required, based on network relationships among institutions that are territorially relevant, through their leadership and the decentralization of decision-making. Governance plays an important role in the establishment of territorial equity, the reduction of territorial disparities and the construction of collective territorial strategies, all of which will promote the development and competitiveness of the Guarda region (Natário, 2014).

The innovation process and the development of Guarda require interaction between the helices that will generate benefits for PG, local companies and the Guarda system of governance, as can be seen from Table 9.

Conclusion

Regarding innovation performance, we can conclude that, for the three helices of the Triple Helix model, innovation processes are a concern that is reflected in their behaviour. They are engaged in the generation of innovation independently, in line with the static characteristic described by Etzkowitz and Zhou (2007), in which the three helices are independent and overlap, and each helix has an internal core and an external field space. Our results for the Guarda region reflect similar conclusions obtained by Pugh (2014):

26) for Wales: ‘according to the Triple Helix model, the three spheres of university, business and government are all required to work together to drive innovation, and the model might not work if one of these three helices is too weak, or the links between them are lacking’.

Our study found that although most of the institutions examined had established cooperation agreements with the other helices, the actual cooperation among them varied significantly, from very weak interaction between companies and PG (7%) and between companies and governance institutions (10%) to more solid interaction between local governance institutions and HEIs/PG (67% and 30%, respectively). The main mode of collaboration between companies and PG was through the provision of services and the use of equipment, and between governance institutions and PG it was the provision of services and the recruitment of trainees.

Thus it is important to strengthen the consensus space, improving the consensus-making process, especially the communication between the main institutional actors (PG, local institutions of the Guarda region, PG centres for cooperation with industry, and companies), in order to stimulate cooperation between them and to develop the knowledge space and promote innovation in the Guarda region, as suggested by Ranga and Garzik (2015).

The benefits to PG from cooperation are obtaining practical knowledge about existing problems, incorporating new information into the processes of teaching and research, and disseminating the image and reputation of the investigator and the institution. For companies and governance institutions, the most important benefits from cooperation are access to the highly skilled resources of HEIs, access to new knowledge developed and the identification of students for future recruitment. Note that the main reason given by companies and the governance system for not hiring PG services was the lack of need and/or applicability. It can be concluded that PG has a key role in building a knowledge-based society, in the development of innovation and in the development of the region.

PG's role in business dynamics and community development through knowledge transfer and entrepreneurship training is reflected mainly in the high proportion of businesses and local governance institutions that have workers trained there and by the satisfaction with the work performed by the professionals so trained. Although the other two helices are also involved in innovation to different degrees, the innovation performance of the region, based on self-reporting, remains low because of the weak interaction between companies and PG and between companies and local governance institutions (a closer relationship, however, was identified between local governance institutions and PG).

Our study has some limitations – specifically, the survey response rates from businesses and institutions, which limited the aspects that could be tested and the fact that the

study focused on only one region. The sample is not representative of the population of enterprises in the region, leading us, statistically, to a case study. Thus, this analysis would be more complete if it were extended to other regions of the country and could have been improved if more research had been done to build a data set (not just the selection of those with an email address in the National Institute of Statistics of Portugal database from 2009). In that regard, future research could use administrative databases, which can address the problems arising from the use of surveys. Also, the research questions that could be tackled based on survey results would benefit from the use of other methods (e.g. the question of why more firms cooperate with HEIs outside the region than with PG).

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